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In My Opinion

Considerations for Culturally Sensitive Traditional Ecological Knowledge Research in Wildlife Conservation

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ABSTRACT Traditional Ecological Knowledge (TEK) is increasingly being applied in the field of wildlife conservation, yet conceptualizations of what TEK is and views regarding whether TEK is science remain diverse and, at times, conflicting in the TEK discourse. Many practical and philosophical challenges come with the pursuit of TEK initiatives, potentially leaving wildlife researchers and managers wondering how to conduct projects effectively and also in a culturally sensitive manner. The consideration of historical and philosophical contexts that affect tribal communities may be beneficial in such cases. I provide a historical context by presenting chronological events of Indian Country in the United States as related to Federal Indian Law in parallel with the development of wildlife management as a profession. Additionally, I explore the philosophical context of TEK as science by discussing Western and Indigenous scientific paradigms and their linkages to TEK. Finally, given these contexts, I provide several suggestions for developing culturally sensitive approaches to TEK research in the wildlife field. © 2018 The Wildlife Society.

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Divergent interpretations of what Traditional Ecological Knowledge (TEK) is and approaches to TEK research persist between Western and Indigenous scientists, scholars, and communities (McGregor 2005, Whyte 2013). The term "Traditional Ecological Knowledge" was coined by Western-trained academics (McGregor 2005). Anthropologists conducted the earliest systematic studies of TEK in the 1950s, with widespread use of the term occurring in the 1980s (Inglis 1993). Although TEK has been acknowledged and legitimized in many Western academic fields, there is no universally accepted definition (Berkes 2012, Whyte 2013). A commonly cited definition is "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2012:7). Scholars have suggested TEK can be thought of as documented ethnoscience enriched with analyses and explication provided by science experts (Snively and Corsiglia 2001). Traditional Ecological Knowledge has been described as being expressed via resource management that takes place according to phenological calendars. For example, the observation of the flowering of a particular plant species can indicate when to engage in harvesting another species or perform a particular land management action (Lantz and Turner 2003).

However, TEK is conceptualized and conveyed differently between Western and Indigenous lenses (Ramos et al. 2016). For many Indigenous peoples, TEK stems from their cosmologies and cultural frameworks, denoting a system of responsibilities in active participation of natural resource management (Whyte 2013). Winona LaDuke, Anishinabe author, and community organizer, describes TEK as "the culturally and spiritually based way in which Indigenous people relate to their ecosystems. This knowledge is founded on spiritual–cultural instructions from time immemorial and on generations of careful observation within an ecosystem" (McGregor 2004:393). For many Yurok, TEK is considered a way of life and can be conceptualized as, "a system where Yurok people and wildlife collaboratively strive to create and maintain balance of the Earth via physical and spiritual management in tandem" (S. C. Ramos, Humboldt State University, unpublished data). Expressed through a cultural lens, an example of Yurok phenology is when frogs start repeating the word "*ke'ween*", they are signifying the onset of *ke'ween* (Pacific lamprey [*Entosphenus tridentatus*]) harvest season (M. Carlson, Yurok Tribe community member, personal communication).

Researchers in applied ecology and natural resource management fields have gained interest in TEK relatively recently (Inglis 1993) and research has been conducted in fields such as forestry (Klooster 2002, Cheveau 2008,

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Trosper and Parrotta 2011), fire ecology (Kimmerer and Lake 2001), and fisheries (Menzies 2006). Traditional Ecological Knowledge has also been applied to wildlife management and conservation in a variety of contexts and geographical locations (Darimont et al. 2005, Dowsley and Wenzel 2008, The Wildlife Society 2010, Reo and Whyte 2012, Polfus et al. 2014). Many researchers have focused on integrating TEK and Western Science (Huntington 2002, Moller et al. 2004). Although Western and Indigenous knowledges have been utilized together to monitor and enhance wildlife habitat and populations, these paradigms are not easy to combine because they are rooted in different philosophies (Moller et al. 2004, Senos et al. 2006). Additionally, there exists unequal political power between Indigenous communities and Western-trained scientists and wildlife professionals (Nadasdy 1999, Shackeroff and Campbell 2007).

Some scholars have raised concerns regarding certain approaches to the integration of Western Science and TEK (Nadasdy 1999). For example, a common approach has been to engage Indigenous communities only to seek the TEK information (e.g., biological data) that benefits and conforms to Western Science and existing management structures (Nadasdy 1999, Dowsley and Wenzel 2008). Distillation, as this approach has been termed, can be perceived as removing TEK from Indigenous cultural contexts, being more exploitative than collaborative (Nadasdy 1999). In the territory of Nunavut in northern Canada, Indigenous knowledge has been directly applied in setting hunting quotas of polar bears (*Ursus maritimus*) and become an integral element of polar bear co-management. However, some Inuit expressed concerns that their cultural understandings and values of polar bears seem to have not been fully included in the co-management framework. There is strong interest in participating in wildlife management, but in a culturally appropriate way. Therefore, researchers encouraged dialogue surrounding Inuit cultural understandings of polar bears, exploration of the linkage of all aspects of Inuit TEK, and integration of these aspects into the Nunavut co-management system (Dowsley and Wenzel 2008).

There are many conceptual and practical challenges in pursuing TEK in Western Science–based frameworks. For example, there is potential for TEK to be used for purposes that are controversial with TEK holders. If an Indigenous community shares their TEK and the information is then used to develop a marine protected area with harvest restrictions, would the community be supportive of such action (Shackeroff and Campbell 2007)? Another challenge is that, often, TEK studies must be conducted separately from wildlife studies because the methods for TEK research are derived from the social sciences. This results in the need for interdisciplinary research (Shackeroff and Campbell 2007); however, wildlife professionals might be unfamiliar with social science methods and how to employ them when working with Indigenous communities (Huntington 2000). Hence, TEK initiatives can require significant time and resources (Shackeroff and Campbell 2007). Yet another challenge stems from the discomfort that can occur for researchers and community members alike in cross-cultural interactions (Huntington 2000). Community members might resist Western Science altogether and might be reluctant to share information with people outside of their community (Huntington 2000, Moller et al. 2004, Dowsley and Wenzel 2008). Further, some wildlife management techniques, such as tagging and collaring, might be viewed as unethical by an Indigenous community. Techniques might be in conflict with traditional values if they are perceived to cause unnecessary suffering or discomfort to animals (Byers 1999).

Given myriad challenges, wildlife researchers and managers might find themselves contemplating how to initiate and facilitate TEK studies. Herein, I present history of Indian Country in the United States most relevant to engaging with TEK and provide suggestions for the development of culturally sensitive TEK research. First, I explore the chronological history of Indian Country in relation to Federal Indian Law and the development of wildlife management as a profession. The purpose of this section is to illuminate the experiences of Indian communities during well-known periods in the wildlife profession in the United States, elucidating the effect of colonialism on Indigenous knowledge systems. As a result of this history, many Indigenous communities have a strong desire to revitalize and maintain their TEK, especially as related to wildlife. Thus, there is a need for researchers to consider this history and the implications of particular approaches to TEK. Next, I explore Western and Indigenous paradigms in the philosophy of science, including TEK as Indigenous Science. The purpose of this section is to present various perspectives and highlight that TEK is often conceptualized differently in Western and Indigenous paradigms. I do not provide an exhaustive account of all literature related to these historical and philosophical contexts; rather, I explore core components as related to the pursuit of TEK studies with wildlife. I conclude with suggestions for culturally sensitive TEK research such as the utilization of Indigenous Research Methodologies, understanding TEK through an Indigenous lens, and the use of equitable terminology for TEK.

Throughout this paper, I use the term "Indian" when referring to standard terminology as applied in U.S. Federal Indian Law, "Tribe" to signify government-level organization of a tribal community and the term "Indigenous" to refer to peoples and communities generally. This paper is intended for agency and tribal wildlife biologists, scholars in related fields, and upcoming wildlife management and conservation professionals who are preparing for increased collaboration among Tribes, universities, and agencies.

HISTORICAL AND CONTEMPORARY CONTEXTS OF THE WILDLIFE PROFESSION AND INDIAN COUNTRY

The contemporary frameworks of Federal Wildlife Law and wildlife management in the United States are rooted in Western ideology, with historical antecedents as early as the Roman Empire. Processes of determination of ownership of

wildlife and regulation of hunting were carried into British Wildlife Law, which later influenced Wildlife Law and management in the United States via European colonizers. Prior to 1900, federal wildlife legislation was sparse, limited in scope, and had relatively minimal impact (Bean and Rowland 1997).

Formal wildlife management as recognized today originated largely in the 1900s and has transformed from being geared toward commodity use to more holistic stewardship (Knight 1996). During the expansion of the United States, many settlers believed wildlife existed for hunting (Knight 1996) and, over time, there was a general recognition that wildlife populations were steadily declining (Bolen and Robinson 2003). Market hunting represents one of the darkest eras of wildlife exploitation in the United States, leading Federal and state agencies to seek scientific information on which to base hunting policies and improve habitat conditions. Trained biologists were needed to study wildlife populations and their ecological associations (Bolen and Robinson 2003). Often associated with Aldo Leopold's landmark text, *Game Management* (Leopold 1933), wildlife management emerged as a science and profession to inform hunting policies and improve habitat conditions (Bolen and Robinson 2003). Consequently, the contemporary wildlife management profession is rooted in the conjunction of ethics, culture, perceptions, and legal concepts (Bolen and Robinson 2003).

As the history of formal wildlife management can be described in chronological phases and intersecting factors, so, too, can the concurrent experience of Indigenous peoples and their relationship to wildlife as affected by Federal Indian Law. For example, before contact with European settlers, Indigenous peoples were intentionally managing the landscape, such as in the use of fire to create wildlife habitat (Anderson 2005, Ramos 2016). During the expansion of the United States, Indigenous peoples were often dispossessed of the lands and natural resources that formed the foundation of their customs (Cronin and Ostergren 2007).

While the discipline of wildlife management and Federal Wildlife Law emerged and developed in the 1900s, Indigenous communities faced cultural genocide—direct assaults on identity and ways of life—through eras of shifting policies of Federal Indian Law (Bean and Rowland 1997, Getches et al. 2005). When President Theodore Roosevelt declared the first federal wildlife sanctuary in 1903, which would lead to the creation of the National Wildlife Refuge System, Indians were in the midst of the Allotment and Assimilation era (1871–1928) of Federal Indian Law (Getches et al. 2005).

This era was characterized by policies intended to "civilize" Indians by forcing them to assimilate into White society. The General Allotment (Dawes) Act of 1887 permitted Indian lands to be surveyed, parceled out, and allotted to individual Indians for the purposes of agriculture or grazing. Parcels that were not allotted were considered as surplus and sold to non-Indians. Through this process, Indian land holdings were reduced drastically, from 55,846,618 ha in 1887 to 19,424,910 ha in 1934 (Greenwald 2002, Getches et al. 2005). United States citizenship was granted to allottees after a 25-year trust period and any other Indian who had abandoned their tribe and adopted White societal norms. Indians as a whole were not granted citizenship until 1924.

In another effort of assimilation, the Federal government's Office of Indian Affairs issued a policy statement in 1921 that determined the sun dance, an Indigenous ceremony, and all other similar dances would be considered Indian offenses and were to be outlawed (Native American Rights Fund [NARF] 1979). With the intent of assimilating Indian children into White society, they were removed from their families and sent into the Bureau of Indian Affairs boarding school system, where they were not permitted to see their relatives or friends. Anything Indian—dress, language, religious practices, and worldview—was uncompromisingly prohibited (Simpson 2004, Getches et al. 2005). Children were forced to learn non-native languages and adhere to Christianity in a system that was intended to "kill the Indian. . .and save the man" (Grinde 2004:27, Spoon and Arnold 2012).

In the era of Indian Reorganization (1928–1945), the design for modern tribal governments was developed. Indigenous peoples were living in poverty and health and education were in a dreadful state (Getches et al. 2005). A year after the publication of *Game Management* (Leopold 1933), the Indian Reorganization Act of 1934 was passed, representing a major shift in federal policy that was focused on tribal self-governance rather than individual assimilation. Under this Act, allotment policy was revoked and tribes could choose to establish a formal government with a council, constitution, and by-laws (Getches et al. 2005). In 1934, the Navajo Tribe, as a governmental entity with jurisdiction, became one of the first tribes to pass regulations to protect wildlife on a reservation (Pearson 1989).

The era of Self-Determination (1961–present; Getches et al. 2005) is marked by the 1975 Indian Self-Determination and Education Assistance Act (25 U.S.C. 450), which was passed with the intention of weaning Tribes from direct federal bureaucracy and allowing them to manage more of their own affairs (Getches et al. 2005). After the 1983 *New Mexico v. Mescalero Apache Tribe* (103 S. Ct. 2378) case, where the Supreme Court ruled that state fish and game regulations do not apply on tribally owned reservation land (Czech 1995, Getches et al. 2005), many tribal councils wrestled with whether to establish wildlife management programs (Pearson 1989). Decision frameworks for some Tribes included consideration of economic cost–benefit analyses, stabilization of wildlife populations, ability to gain revenue, preservation of traditional values via conservation of culturally significant species, and advancement of political interests with the federal government, state government, and other entities (Pearson 1989). Today, Tribes retain a level of self-governance, operate businesses and exercise hunting and fishing rights within their jurisdictions (Czech 1995).

Many Tribes have chosen to exercise their authority to manage wildlife with the goal of improving the health and wellbeing of their communities via cultural revitalization and practicing TEK (Getches et al. 2005, Cronin and Ostergren

2007, Ramos et al. 2016). Under myriad forms of agreements, Federal agencies and Tribes have collaborated on TEK projects in natural resource management, including some wildlife-related projects (Czech 1995, Sepez and Lazrus 2005). Agencies such as the U.S. Fish and Wildlife Service and National Park Service have developed websites to provide resources on TEK (National Park Service 2016, U.S. Fish and Wildlife Service 2016). The National Park Service also published a report regarding TEK in wildlife conservation as germane to National Park Service initiatives and service-wide policies. The report also discusses the importance of wildlife and the persistence of TEK to Indigenous communities (Ramos et al. 2016).

Although TEK has entered the discourse in wildlife management and conservation, and many Tribes are working to sustain their TEK, there exist legal and jurisdictional challenges for Indigenous communities to carry out their TEK. For example, TEK practitioners historically rotated harvest areas, performing multiple-species management across multiple habitat types and allowing time for species to recover. However, the institution of a private property system divided the land into various jurisdictions, limiting access of Indigenous peoples to many usual and accustomed places (Senos et al. 2006). Indigenous communities are sometimes asked about their TEK in relation to lands or natural resources that they cannot legally access; in such cases, they might be reluctant to collaborate (Ramos et al. 2016). Thus, historical and contemporary natural resources and Federal Indian laws and policies influence whether and how TEK is practiced.

Federal Indian law is the product of colonization and corresponding displacement of Indigenous peoples (Frickey 1993); the mistreatment of Indigenous peoples persists in the memories of those communities, at times coloring the way in which they view contemporary situations (Ramos 2016). Colonialism resulted in dramatic shifts in the human–environment relationships of Indigenous peoples and resulted in despair, discrimination, and poverty, as well as high rates of drug and alcohol abuse, domestic violence, and suicide in many communities (O'Brien 2008). Studies of TEK that neglect the linkage between history and the current state of Indigenous knowledge systems, and exclude cultural context and spirituality, are interpreted by some scholars as continued oppression and assault on cultural survival (Simpson 2004). Many Indigenous communities strive for the revitalization and persistence of TEK—as interpreted through their cultural lens—because it is vital to cultural survival. The current era of Indian self-determination is critical because self-determination facilitates the revitalization of TEK (Simpson 2004).

WESTERN AND INDIGENOUS PHILOSOPHIES OF SCIENCE AND TEK AS INDIGENOUS SCIENCE

The philosophy of science that many know today is sometimes referred to as "Western Science" (Kawagley et al. 1998). Although it is internationally recognized, it has a distinctive origin in Western Europe and took on much of its present character during the scientific revolution of the sixteenth and seventeenth centuries (Snively and Corsiglia 2001). Western Science tends to perpetuate certain epistemological and axiological systems, which contribute to its Western cultural character. Much of Western Science includes controlled experimentation or tests of falsifiable hypotheses with empirical data collected through experimentation or observation (Sagasti et al. 1994, Kawagley et al. 1998).

Knowledge production in Western Science is considered legitimate and professional in a distinct social system and institutional framework (Sagasti et al. 1994). In the Western scientific paradigm, to be credible, knowledge production must follow the scientific method. Practices that do not are not viewed as valid (Latour 1987, Fortmann and Ballard 2011). Additionally, credibility of knowledge producers is often aligned with social power, excluding those who do not have certain social markers, such as formal education (Fortmann and Ballard 2011).

Although many people have been taught only the Western philosophy of science, some scholars contend that there exist many philosophies of science in the world (Ogawa 1995, Snively and Corsiglia 2001). Some scholars have perceived science as a way of understanding the world and how to interact with it (Cajete 1999, Fortmann and Ballard 2011). The philosophy of Indigenous Science encompasses all of the kinds of knowledge within an Indigenous mindset (Cajete 1999). Similarly to Western Science, knowledge production in Indigenous Science operates through a process of observation, theory, experimentation, and replication (Baker 1996, Kawagley et al. 1998). Processes of science that include rational observation of natural events, development of technology, classification, and problem-solving are woven into all aspects of Indigenous cultures (Baker 1996, Kawagley et al. 1998). Expressions of scientific thinking are abundant throughout Indigenous knowledge areas such as agriculture, astronomy, and fire ecology (Baker 1996). Explanations of many phenomena have been validated via a "massive set of scientific experiments continuing over generations" (Kawagley et al. 1998:7) by people whose survival depended on correct interpretations of observations, such as migratory patterns of wildlife and seasonal changes. As Indigenous peoples demonstrate knowledge production in their daily lives, some, such as the Yupiaq, see themselves as producers of knowledge (Kawagley et al. 1998).

Many Indigenous peoples use the terms "knowledge" and "science" interchangeably because their scientific knowledge is not compartmentalized as in Western Science (Cajete 1999). For example, to design a fish trap and successfully catch fish, one must know fish behavior, the river system, how the trap will behave and operate given certain conditions, climate, and weather (i.e., one must have knowledge of physics, biology, and engineering; Kawagley et al. 1998). Further, for science to take place, there must exist knowledge. Following this line of reasoning, TEK is considered a branch of Indigenous Science by some scholars (Snively and Corsiglia 2001).

However, the mere consideration of the existence of Indigenous Science is a contentious topic because it can lead

to a clash of perception and experience with many who identify with Western Science (Baker 1996). One area of contention concerns oral tradition. Traditional Ecological Knowledge often becomes part of the oral tradition of a specific Indigenous group and is generally transmitted in that manner, such as in descriptive names and stories where abstract principles are expressed metaphorically (Baker 1996, Snively and Corsiglia 2001). Some scholars contend that anecdotal evidence and orally transmitted information over generations cannot be tested (Warwick 2010). Although such views exist, some scholars suggest that the concept of TEK may be understood as a collaborative one; it serves to invite diverse populations, such as Indigenous and non-Indigenous peoples, to continually learn from one another about how each approaches the very question of what knowledge is and how these various approaches can be utilized together to better steward natural resources (Whyte 2013).

Another area of contention concerns spirituality. Indigenous Science and Indigenous conceptualizations of TEK are essentially theistic and spiritual; they are not so much bodies of knowledge as ways of perceiving, making sense of, and relating to the world (Baker 1996, Ramos 2016). Spirituality contributes to TEK and tribal wildlife management in that periodic restrictions on wildlife harvest are often ritualized into cultural and spiritual practices (Senos et al. 2006). The importance of spirituality as a component of TEK is exemplified in Ojibwe hunters' cultural protocols, which include giving thanks to and asking forgiveness and permission of a deer, as a spiritual being, to take its life (Reo and Whyte 2012).

Spirituality and other aspects of TEK fall outside of the realm of Western Science, so some explicitly argue that TEK is not science (Senos et al. 2006, Warwick 2010, Berkes 2012). It is reasoned that science should not be regarded as a belief system. If TEK is science, there is concern that mythology, and possibly religion, might enter the scientific discourse (Warwick 2010). Many non-Indigenous peoples acknowledge Indigenous art, music, and literature but fail to accept the existence of Indigenous Science (Cajete 1999, Snively and Corsiglia 2001). However, many Indigenous peoples accept Indigenous Science and TEK as a legitimate ways of knowing (Baker 1996, Cajete 1999, Ramos 2016).

SUGGESTIONS FOR CULTURALLY SENSITIVE TEK STUDIES

Researchers and managers who intend to conduct TEK studies should take into account the historical and philosophical contexts presented here, which may lead one to consider 1) how Indigenous communities experienced colonization through the application of Federal Indian Law; 2) how practicing TEK may contribute to resilience and cultural revitalization of those communities; and 3) the contemporary legal and social structures by which Indigenous communities must operate. Given these considerations, I discuss several suggestions that wildlife researchers and managers can consider to facilitate culturally sensitive approaches to TEK and working with Indigenous communities. I encourage those who are interested to explore additional suggestions and detailed guidance provided in other works specific to agency biologists, such as those in the National Park Service (Ramos et al. 2016).

Recognition of the importance of cultural survival of Indigenous peoples at both the national and international levels can strengthen relationships with Indigenous communities. The United Nations Declaration on the Rights of Indigenous People states that Indigenous peoples have the right to "...maintain, control, protect and develop their cultural heritage, traditional knowledge, and traditional cultural expressions, as well as the manifestations of their sciences ..." (United Nations General Assembly 2007:11). By supporting these rights, as well as Tribal self-determination, researchers can demonstrate cultural sensitivity in TEK projects. Guiding questions can be helpful in such endeavors and might include: What considerations are important for cultural survival of Indigenous peoples? And, how can purely data-driven approaches be avoided?

One way to facilitate the application of culturally sensitive TEK research and advance Indigenous views and objectives in cultural survival is to use decolonizing strategies, which involve deconstruction of the relationship of colonialism to Indigenous knowledge so that Indigenous knowledge systems can be revitalized and flourish (Smith 1999, Simpson 2004). One such strategy is the use of mixed-methods approaches to research with Indigenous communities. A mixed-methods approach may include Indigenous research methodologies, an area of scholarship intended to produce ethically and culturally appropriate studies with Indigenous peoples (Botha 2011). Indigenous research methodologies emphasize the development of appropriate theories and practices, decolonizing the areas of collaboration between Indigenous and Western modes of social sciences research (Smith 1999, Simpson 2004, Botha 2011).

Another decolonizing approach researchers can take in culturally sensitive TEK projects is to support the revitalization of Indigenous languages. Some researchers have worked with Indigenous communities to develop terminology that conveys TEK through their cultural paradigm. For example, TEK can be understood as *hlkelonah ue meygeytohl* (to take care of the Earth) for the Yurok and *Inuit Qaujimajatuqangit* (that which has long been known by Inuit) for the Inuit (Berkes 2012, Ramos 2016). Use of culturally sensitive social science methodologies and exploration of language with communities might strengthen relationships and alleviate some of the challenges in the interdisciplinary nature of TEK studies, as well as cross-cultural exchanges with Indigenous communities.

There is a need for natural resource managers and policymakers to gain a clearer understanding of the perspectives of Indigenous peoples in TEK and natural resources matters (Bengston 2004). Therefore, another manner in which researchers can be culturally sensitive is by accepting Indigenous understandings of TEK as Indigenous Science and using equitable terminology when referencing TEK in conjunction with Western Science. Hesitation in the literature regarding the assertion that TEK

is science is indicated by the use of phrases similar to "TEK and science." Such phrases might be perceived as implying that the latter is science and the former is not. Researchers and managers can consider the use of "Traditional Ecological Science" and "Western Ecological Science" or, alternatively, TEK and "Western Ecological Knowledge," as more equitable terms (Ramos et al. 2016). Continued dialogue regarding appropriate terminology might be fruitful in the TEK discourse overall, as well as in wildlife TEK studies.

For context in this paper, I have presented perspectives that are in agreement with and opposition to TEK as science. The inclusion or exclusion of spirituality in science remains an area of separation between Indigenous and Western paradigms. Traditional Ecological Knowledge research often excludes an awareness of the lens in which Indigenous peoples conceptualize science and TEK, through their belief systems, voices, and stories. Traditional Ecological Knowledge is Indigenous Science and includes a spiritual component; therefore, it is appropriate for the cultural beliefs and spirituality of a community to be acknowledged and included in research, to the extent desired by the community, and for TEK to be explicitly addressed as science.

Although Western and Indigenous scientific paradigms differ in some aspects, both can be valid, and each is consistent with a particular worldview (Cajete 1999). It can be useful to broaden one's understanding by looking for areas of overlap between Indigenous scientific views and ideals shared by wildlife scientists with other frames of reference (Berkes 2012). For example, Aldo Leopold's Land Ethic shaped wildlife science and changes the role of man from conqueror of the land-community to a member of it. The ethic implies respect for the land, which includes soils, waters, plants, and animals. Leopold's land ethic posited that each individual is a member of a community of interdependent parts and ethically bound to maintain cooperative relations with the biotic community (Leopold 1970). Similarly, in an Indigenous land ethic, concepts of kincentricity and kincentric ecology denote humans and nature as relatives (Salmón 2000). Another example is the concept of ecosystem management, which includes stewardship of biological diversity and is a factor in contemporary wildlife management (Knight 1996). Ecosystem management is integral in an Indigenous TEK framework, but may be conceived as tending to, or caring for, natural resources. In Yurok TEK, humans are considered stewards of natural resources (Ramos 2016). Traditional Ecological Knowledge studies must include ethics and beliefs of Indigenous peoples for wildlife management strategies to be effective in both biological and cultural terms (Stevenson 1996).

The concept of applying ecological knowledge to maintain balance is yet another area of overlap between Western and Indigenous paradigms as related to natural resources management. Following drastic declines and extinctions of wildlife due to hunting by settlers and resulting management and conservation efforts, Western-trained wildlife professionals have come to realize that wildlife are renewable and with wise management can be perpetuated indefinitely (Bolen and Robinson 2003). Wildlife management has transformed from a focus on game management and been defined as, "the application of ecological knowledge to populations of vertebrate animals and their plant and animal associates in a manner that strikes a balance between the needs of those populations and the needs of people" (Bolen and Robinson 2003:2). This definition aligns with Yurok TEK, where creating balance among humans, the environment, and animals is fundamental to natural resource management (Ramos 2016).

Lastly, development of culturally sensitive research frameworks is important in TEK initiatives. An example of a philosophical framework that might change the position from which one approaches TEK research is interdependent science, which is research conducted collaboratively between conventional and civil scientists, such as TEK holders (Fortmann and Ballard 2011). These partnerships should include consideration of Indigenous spirituality. An example of a collaborative natural resource management project that takes spirituality into account comes from work with the Nuwuvi (Southern Paiute). The Nuwuvi are of the Great Basin and northern Mojave Desert, where much of their ancestral land is under federal jurisdiction. The Nuwuvi conduct physical and spiritual management in tandem; spiritual management, such as songs and prayers in Nuwuvi language, is considered essential. Many Nuwuvi felt that their ancestral lands were out of balance, in part as a result of the lack of Nuwuvi management due to limited access to resources. Academic researchers, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the Nuwuvi collaborated to develop a framework that fosters Nuwuvi ecological knowledge and place-based spirituality. However, rather than solely documenting information, collaborators developed and implemented mutually agreed upon management goals. Federal agency representatives noted that this approach had improved communication and built rapport between tribal communities and agencies. Additionally, the Indigenous collaborators appreciated having influence on the research parameters, methods, and outcomes (Spoon and Arnold 2012).

Although there has been substantial growth of academic literature on TEK, worldviews and value systems that influence tribal resource management are often neglected and are possibly the least studied aspects of TEK as applied to wildlife research and management (Nadasdy 1999, Fortmann and Ballard 2011, Reo 2011). Successful TEK research is conducted in an ethically sound and methodologically rigorous manner, where goals are meaningful to both the researcher and the community (Shackeroff and Campbell 2007). I encourage those who are considering TEK research pertaining to wildlife to contemplate the topics I have presented and to explore culturally sensitive approaches for collaborating with Indigenous communities.

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